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Simpson

INSTRUMENTS THAT STAY ACCURATE

OPERATOR'S MANUAL

VOLT-WATTMETERS MODELS 391 AND 392

SIMPSON ELECTRIC COMPANY
5200 W. Kinzie St., Chicago 44, Illinois, ES 9-1121
In Canada, Bach-Simpson, Ltd., London, Ontario

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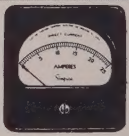
2½" RECTANGULAR
ACCURACY: ±2%
SCALE LENGTH: 1⅞"



3½" RECTANGULAR
ACCURACY: ±2%
SCALE LENGTH: 2⁹⁄₁₆"

2½", 3½", 4½" WIDE VUE
ACCURACY: ±2%

2½" or 3½" ROUND
ACCURACY: ±2%
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ACCURACY: DC ±2%
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OPERATOR'S MANUAL

SIMPSON VOLT-WATTMETERS MODELS 391 AND 392

SIMPSON ELECTRIC COMPANY

5200 W. KINZIE ST., CHICAGO 44, ILLINOIS

TELEPHONE ESTEBROOK 9-1121

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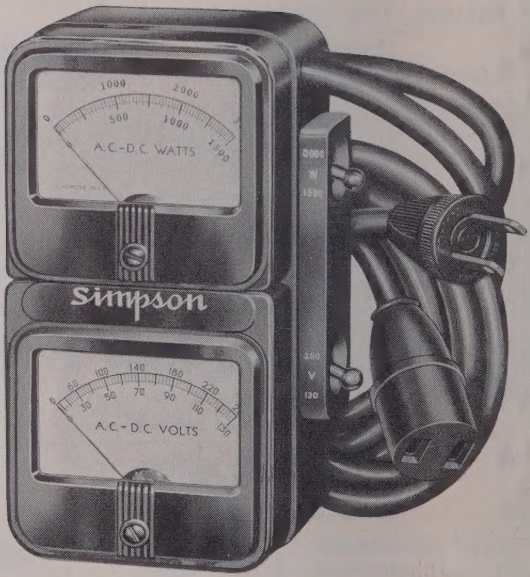


FIGURE 1. SIMPSON VOLT-WATTMETER MODEL 391
RANGE 1500 TO 3000 WATTS

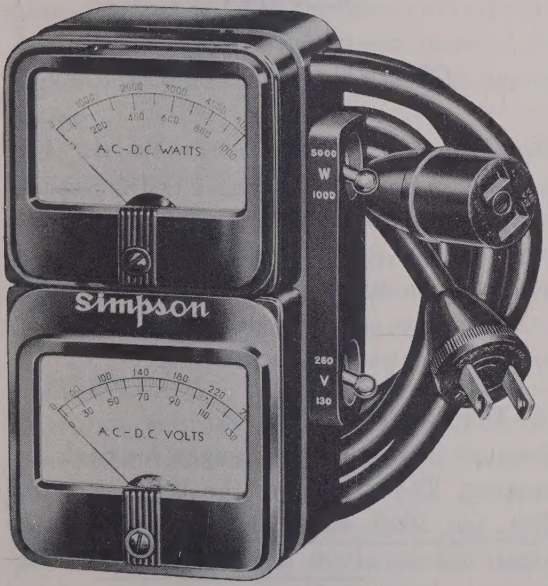


FIGURE 2. SIMPSON VOLT-WATTMETER MODEL 392
RANGE 1000 TO 5000 WATTS

SECTION I

GENERAL DESCRIPTION

The Simpson Volt-Wattmeters Models 391 and 392 are shown in figures 1 and 2 respectively. They are similar instruments, and have similar appearances and uses. Each instrument is made up of two separate indicating meters; the top part is a wattmeter and the lower part is a voltmeter.

WATTMETER RANGES

There are two wattmeter ranges for each instrument. The ranges for the Model 391 are 1500 and 3000 watts. The ranges for the Model 392 are 1000 and 5000 watts. This provides two popular sets of ranges from which you can select the combination which better fits your requirements.

VOLTMETER RANGES

There are also two voltmeter ranges for each instrument, and these ranges are the same

for both models. The low range is 130 volts. The high range is 260 volts. These ranges were selected to give the best coverage for nominal 110 and 220 volt power sources, together with their highest and lowest normal limits.

AC OR DC

Both meters in each instrument will operate equally well on either DC or AC circuits. The wattmeter is a dynamometer type, and the voltmeter is a vane type movement.

POWER LEADS

There are two heavy power leads which are connected permanently inside the case of each instrument. The longer lead is terminated with a standard male power plug which you can insert into any ordinary power outlet. As soon as you insert this plug in a power outlet, the voltmeter in the lower half of the case will indicate the amount of voltage in the circuit. The voltmeter will continue to indicate as long as you have the power plug connected in the outlet.

The second power lead is shorter and terminates in a female power outlet. Connect the power cord of the device which you are going to use to measure wattage in this outlet. Line voltage with a strength indicated on the voltmeter will be applied to the device to operate it. The current which the measured device allows to flow through the power line will determine, along with the line voltage, how many watts are indicated on the wattmeter portion of the instrument.

TERMINAL CODING

There is a polarization marking on the termination of each power cord. A dot of white lacquer on each plug and receptacle identifies the contact for the white lead. This lead is continuous between the two cords. If you are working with DC, and require a definite polarity of voltage application, use the white dots to identify one continuous lead through the instrument circuits. The other contact on each termination, unmarked, is is for the other continuous lead.

RANGE SWITCHES

There are two switches on the right hand side of the instrument. The one at the top, opposite the wattmeter, is a range switch for the wattmeter. With the switch handle in its lower position, the lower range is connected. For the Model 391, this is 1500 watts; for the Model 392, this is 1000 watts. When the wattage range switch is in the upper position, the higher range is connected. In the Model 391, this is 3000 watts; In the Model 392, this is 5000 watts.

The switch at the bottom on the right hand side of the instrument is the voltage range switch. In either model, this sets a range of 130 volts when it is in the down position, or of 260 volts when it is in the up position.

METERS

The nature of the meter movements in the Simpson Volt-Wattmeters is such that there is an automatic power factor correction for all wattage readings. This means that the wattmeter actually reads true power, whether

the power source is DC or AC, and whether the load is resistive, inductive, or capacitive.

This feature provides a distinct advantage for measuring such effects as capacitor motor starting characteristics, in which the phase relations change abruptly. By having an instrument which indicates true wattage, you can better analyze the way in which each circuit and device operates.

ACCURACY

Simpson Volt-Wattmeters Models 391 and 392 have an accuracy of ±3% of full scale for the wattmeter, and ±3% AC and ±5% DC for the voltmeter. Both the wattmeter and the voltmeter are AC-DC instruments, and you will not have to compensate for any frequency within the normal range of power source frequencies.

SIZE AND WEIGHT

The case dimensions for both models are 3" x 5-7/8" x 2-1/2". The weight is only 1-3/4 lbs. There is a specially designed

carrying case available for Simpson Volt-Wattmeters; get one from your parts jobber and protect your instrument.

SECTION II

OPERATING INSTRUCTIONS

ZERO BOTH METERS

Before you use your Simpson Volt-Wattmeter, be sure that both of its meters read zero when there is no power applied and when the instrument is in its operating position. There is a small zero setting screw in the face of each meter just below its dial. These screws can be seen in the illustrations of the front panels, figures 1 and 2.

Use a small screwdriver to rotate each screw either clockwise or counterclockwise until the knife-edged pointer rests over the zero indication at the left hand side of the dial. Each of the two movements operates independently, so set both of them while there is no power connected to the instrument.

SET RANGE SWITCHES

Set the wattmeter range switch in its up position (high range); this will help to protect the instrument from an overload. After you have observed the first reading on the wattmeter, you can set its range switch for the lower range if the wattage is within the lower range.

Set the voltmeter range switch according to the amount of line voltage expected from the power source. If you are in doubt, set this switch at 260 volts as a protection to the instrument. Then you can change the range switch setting to 130 V if you find that the line voltage is less than 130 volts.

CONNECT TO POWER SOURCE

Plug the male power plug at the end of the longer power lead into a power line outlet. A universal type plug is furnished for this termination on the instrument lead, and it will fit into standard type power outlets commonly available for all power line connections.

If your power source does not have a convenience outlet into which this plug will fit, make an adapter with which you can connect the two plug contacts to the two sides of the power line which you are using. Use large enough wire and contacts in your adapter to carry all the current for the device in which you are going to measure wattage.

VOLTMETER INDICATES

As soon as you connect the line with the male plug to a source of power, the voltmeter at the bottom of the front panel in the instrument will register line voltage. This will continue to indicate the voltage available from the power source as long as the plug is connected, whether you have any device connected and operating or not.

CONNECT THE DEVICE IN WHICH YOU WISH TO MEASURE WATTAGE

Plug the power lead for the device in which you wish to measure wattage into the female outlet at the end of the shorter power cord of the Volt-Wattmeter. Turn on the power

switch, if there is one, in the device.

If the device which you are measuring does not have a power plug termination on its power cord, put one on so that you can connect it to the Volt-Wattmeter circuit while you measure its wattage.

WATTMETER INDICATES

As soon as any current begins to flow through the device connected to the power lead of the instrument, it will also flow through the wattmeter portion of the Volt-Wattmeter. This will cause the wattmeter to indicate how much wattage is being consumed.

STARTING SURGES SHOWN

Many electrical devices have starting currents which are greater than their normal operating currents. The pointer on the wattmeter will indicate these conditions accurately by showing a higher reading while the larger current passes through the circuit, and then a lower reading when the device has assumed its proper operating condition.

MEASURING WATTAGE IN TWO OR THREE PHASE CIRCUITS

The Simpson Volt-Wattmeters are single phase instruments. To measure either voltage or wattage, or both, in two and three phase circuits, measure each phase separately. The nominal voltage for a multi-phase circuit is the voltage of each phase. The total wattage is found by adding the wattage read in each phase. The wattages for the different phases are usually equal, but may be different; measure each one to be sure.

PREVENT OVERLOADING THE INSTRUMENT

Too much current through the current coils of the wattmeter can overheat them and cause permanent damage if it is not removed quickly. The current rating for the Simpson Models 391 and 392 is 10 amperes normal, 20 amperes maximum intermittent, and 40 amperes momentarily. Do not exceed the safe operating limits for your instrument.

AMPERAGE CALCULATIONS

You have no meter with which you can read

the circuit current directly, but the wattmeter indication is an index to the amount of current. For DC circuits, watts are mathematical products found by multiplying volts times amperes. For AC circuits, this product has to be multiplied by the power factor, which is always equal to or less than 1.

Since you can read both the volts and the watts at the same time on your instrument, calculate the approximate circuit current for each application with this related information. You can be sure of the current for DC circuits, but you can only obtain a relative idea of the current for AC circuits, which is usually satisfactory for this purpose. Use the formula:

$$I = \frac{W}{E}$$

where I = current in amperes,
W = power in watts,
and E = volts.

For example, suppose that your voltmeter shows 115 volts when your wattmeter shows 2700 watts. Using the formula to calculate

the current, you find that you have about 23.5 amperes flowing through the circuit and through the current coils in the wattmeter.

$$I = \frac{W}{E} = \frac{2700}{115} = 23.5 \text{ amperes (approximately)}$$

If this measurement is in a DC circuit, this is the circuit current. If the circuit is AC, there is at least this much current and maybe more, depending on the power factor. In either case, the amount of current is enough that you will know that you cannot leave the Volt-Wattmeter connected for any length of time without causing damage to the current coils.

CALCULATE SAFE WATTAGES

To be sure of maintaining a safe operating condition with your instrument, mentally calculate the maximum safe operating wattage for each indication when you have line voltage applied to the Volt-Wattmeter, and before you connect power to any device which you are going to measure. Then you will know when you are operating within a range which either is, or is not, dangerous

to the circuits in your meter. Use the formula:

$$W = E \times I$$

where W = power in watts,
E = volts,
and I = current in amperes.

Note that power factor has again been disregarded, so this is not a foolproof calculation for AC. However, the approximation which you get with it will serve the purpose in most cases.

For example, using the above formula, suppose that you plug in your power cord and find that the line voltage is 120 volts. Multiply this by each of the three current values which represent safety or danger for your circuit. They are 10, 20, and 40 amps.

The three results which you get will be 1200, 2400, and 4800 watts. This means that any wattage indication up to 1200 watts will probably be caused by a low enough

current that you can leave the device connected in the Volt-Wattmeter circuit for any desired length of time while you observe its operation.

HOW TO USE WATTAGE CALCULATIONS

If the reading is between 1200 and 2400 watts, leave the device connected while you make the wattage measurements which you want, but then disconnect the circuit and remove the wattmeter to let it cool (if it is hot) before you connect another device to it. If the value is between 2400 and 4800 watts, just connect it long enough to make a quick reading, and then disconnect it as soon as possible to prevent damage to the meter.

These calculations assumed that the line voltage was 120 volts. If you connect your Volt-Wattmeter to a power circuit and find that the voltage is only 105 volts, the three values of wattage would be 1050, 2100, and 4200. If the voltage is 125, the three wattage values are 1250, 2500, and 5000.

For nominal 220 volt circuits, less current is required to produce similar wattages. For instance, if the voltage is 220 volts, 2200 watts is indicated with only 10 amperes flowing through the circuit. Twenty amperes make the wattage 4400, and 5000 watts requires only about 22.7 amperes.

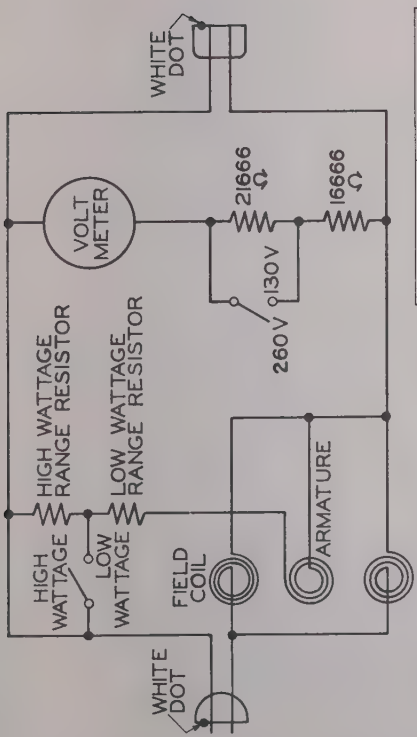
SUMMARY

So, mentally calculate the wattages which indicate dangerous current through your wattmeter when you connect the instrument and read line voltage. Protect your instrument from being damaged by this overheating in the current coils of the wattmeter.

SECTION III

MAINTENANCE

Keep your Simpson Volt-Wattmeter clean and free from dirt and grease and prevent it from any overloads, as suggested in Section II. Your instrument should give you many years of trouble-free service.



	MODEL 391	MODEL 392
HIGH WATTAGE RANGE RESISITOR	17000 Ω	72500 Ω
HIGH WATTAGE RANGE RESISITOR	15000 Ω	16100 Ω
HIGH WATTAGE RANGE	3000	5000
LOW WATTAGE RANGE	1500	1000

FIGURE 3. OVERALL SCHEMATIC DIAGRAM,
MODELS 391 AND 392

REPAIRS

If you should damage the instrument or any of its circuits, return the entire Volt-Wattmeter to the repair department at the Simpson Electric Company factory in Chicago, or to any of its authorized repair stations. Trained repairmen with proper tools, experience, and the correct replacement parts will put your instrument back in working order for you at a minimum charge.

Be sure to always accompany any instrument which you send in for repair with a letter to indicate two things. First, tell what you think is wrong with your instrument and why; this will save repair time so that your repair can be done at less expense to you. Second, indicate whether you want the repair department to go ahead with whatever repair is necessary, or whether you want to know what the estimated repair cost will be before they begin work on your property.

SECTION IV

APPLICATIONS

ANALYZE SERVICE CONDITIONS

The Simpson Volt-Wattmeters Models 391 and 392 have been especially designed for use when you are analyzing service complaints on refrigerators, air conditioners, freezers, ironers, washers, electric heaters and irons, oil burner motors, fans, radios, television sets, lighting units, and a variety of other appliances and electrical devices.

LABORATORY USES

These instruments are also valuable for laboratory analysis of operating characteristics of devices which have, for instance, high starting current with or without regulation, and then a lower normal operating current. They can show the electrical effects of mechanically loading a motor. They can show the output ability of a power source by showing the voltage at the same time as the wattage; as the load is increased it draws

more current, and a power source with only a limited capacity to furnish power will decrease in terminal voltage.

By watching both the wattage, for loading, and the voltage, you can determine the relative ability of the power source to furnish power into an external circuit.

CHECK EFFICIENCY OF POWER LINE

This same idea can be used to check the efficiency, for instance, of a distribution line in an electrical installation. Suppose that a line from the fuse box to an automatic washing machine is about 100 feet long and has #14 AWG wire for its two leads. When you plug the power lead for your Volt-Wattmeter into the outlet for this circuit, the voltmeter shows line voltage. For our example, suppose that this is 115 volts. Now connect the power plug for the automatic washer into the receptacle at the end of the short lead on your Volt-Wattmeter and turn on the switch for the washer.

Watch both the wattmeter and the voltmeter as the washer goes through each of the parts

of its complete cycle. Whenever it goes through a part of the cycle where the motor is started or accelerated, the pointer on the wattmeter will move up the scale and then drop back after the motor has come up to speed. When the wattmeter pointer moves up the scale, the voltmeter pointer will move down, indicating that the loading effect of too small a lead wire has decreased the efficiency of the line. If the power line from the fuse box had been made up of heavier wire (as it should be), the drop in voltage during the time when the circuit requires higher currents would be less.

DETERMINE POWER LINE ABILITY

Use the same idea to analyze the ability of a distribution line already installed to handle the added load of another device which you are to connect.

With your Volt-Wattmeter connected in the line which you wish to test, turn on all the devices which you would normally have on at one time on this line, and watch your voltmeter for an indication of the loading effect of the devices already connected. Then, if

the voltage has not dropped more than, say, 10%, add your new unit to the same line. Look at the voltmeter again. If it still has not dropped more than 10%, you can probably add it to the same line. But if there is more drop and more loading than that, it is advisable to either add a new distribution line or to re-wire the existing line with heavier wire. The 10% figure is not hard and fast, but is an approximate value which you can use as a guide until you have had a chance to adjust it through experience.

Whenever possible, always analyze each evidence of trouble in an appliance or electric device and determine its location and what kind it is before you begin to fix it. If, for example, an electric ironer will not operate, and the wattmeter and voltmeter both show very low readings, there is no reason to tear into the circuits of the ironer; the trouble is in the power line. Use your Volt-Wattmeter to tell you the whole story.

ANALYZE HEATING DEVICES

There are getting to be more and more electrical heating devices in use in the ordinary

household. Each of them has to be serviced occasionally. The Simpson Volt-Wattmeter is an instrument which will provide excellent and accurate trouble shooting information when you work on any such device. Here is a list of a few of the items which will fall into this category:

Electric space heaters, with or without a fan.
Electric irons.
Electric blankets and sheets.
Automatic coffee makers.
Electric hot water heaters.
Electric cooking utensils and roasters.
Bottle warmers.
Corn poppers.
Toasters.
Waffle irons.
Vaporizers.

There are many more, but this list will serve to point out some of the kinds of devices which you will be called on to service and on which you can use your Volt-Wattmeter to advantage.

CHECK RATED WATTAGE

Normally, the wattage rating of each of these appliances will be stamped or marked somewhere on the unit. It may be on the nameplate, or on the base or the under-side of the case. This rating will assume a nominal amount of line voltage, and the voltage rating will accompany the wattage rating, because these are related. In order to have the rated wattage in a device which is in good condition, the power line voltage must be at its rated value.

WATTAGE TOLERANCES

Allow considerable tolerance when you consider whether or not a wattage rating indicates that a device is operating satisfactorily. It may vary as much as 20% above or below the rated wattage value without indicating that anything is wrong. But if the wattage indicated is outside these limits and the voltage indicated on the voltmeter portion of your instrument is within its correct range, trouble is indicated.

WATTAGE INDICATION TOO HIGH

If the wattmeter shows that the device is operating at too high a wattage, this means that there is more than the normal amount of current flowing through it. The only reason for too much current is a decrease of resistance. Look for a short or a partial short in the circuit.

This could be caused by having something drop into the heating element and short across the coils of heating wire. It could also be caused if there is a formation of carbon between the coils or between the wires which connect power into the circuit. Inspect the appliance to locate the short and then eliminate whatever is causing it.

WATTAGE INDICATION TOO LOW

If your wattmeter shows that the device is operating with too low a wattage, this means that there is less than the normal amount of current flowing through it. This would be caused by an increase of resistance in the circuit.

Loose or corroded connections between the power wires and the internal circuits are typical of the troubles which will cause these indications. If there are two or more parallel paths through which the current can flow in the heating circuits, one or more of these parallel paths may be open. Inspect the device with these ideas in mind.

THERMOSTATICALLY CONTROLLED HEATING UNITS

Many electrical heating devices have automatic thermostatic control which will open the circuit to the heating element or will add resistance in series with it in order to reduce its effect after the desired temperature is present in the material which is being heated. Most devices are also set so they will go on again when the temperature has dropped through some definite range.

In some devices this may be a wide range of temperature variation, so the element will be off for a long period of time before it turns itself on again; in others, such as a new preheater for dental hydrocolloid materials, the temperature will be held within a fraction of

a degree. To hold a steady temperature, a heating element will be turned on- off- on-and-off with a change every few seconds after it has once reached the temperature for which it has been set.

ON-OFF TIMING INDICATED

Your Volt-Wattmeter will register the exact timing of these thermostatic control circuits. It will indicate quickly whether the device has a completely open circuit during its cooling period, or whether it has a decreased loading with an increase of series circuit resistance.

By relating these characteristics of operation to those which are expected of the device (see the manufacturer's instructions), you can recognize proper and improper circuit operation. Know what to expect to find when you open the circuits of the device which is not operating properly; this will save your time and increase your efficiency.

CHECK DEVICES WHICH ARE POWERED WITH A MOTOR

There is an apparently limitless list of

devices which contain electric motors. Each one is an item which you may be called in to service at any time. In these service problems, use your Simpson Volt-Wattmeter to analyze circuit operation wherever possible before you begin to service the equipment.

All motors, large or small and any type, have one electrical characteristic in common which you should expect to find with your Simpson Volt-Wattmeter. When they first start, they draw a heavier current (shows as higher wattage) than when they are up to full speed. For larger motors, line voltage will probably decrease due to the load while the motor is accelerating, and then will return to normal when the motor is up to speed so that it does not draw as much current.

MOTOR STARTERS

Many motors have special starting circuits, like capacitor starters. In these, the centrifugal force present in the rapidly rotating armature will throw an internal automatic switch to change from a high current to a low current circuit when speed has been attain-

ed. This will show on your Volt-Wattmeter with a sudden change in the wattmeter indication at the same time when you hear an audible "click" in the motor; the click is the switch being changed.

SMALL MOTORS

If there is no starting circuit, such as in low powered electric fan motors, the wattage indication will decrease gradually from the higher starting value down to the lower running value.

LOADING EFFECTS

Another characteristic which is true for all motors is that the mechanical load which the motor is forced to move will in part determine the wattage which the motor will use. This point is an excellent index into installation and maintenance of load adjustments on the motor, as well as a big point to assist you in trouble-shooting.

AUTOMATIC WASHING MACHINE

One example is a point in the installation instructions for a well-known automatic washing machine. When the washer has been

installed in its operation position in the customer's home, and it has been run through its cycle to see that all the parts are working together properly, the final adjustment is the spring tension against the idler pulley on the drive belt. This is to be adjusted while the washer is operating in its spin cycle. It is adjusted until the wattage consumed by the washer is a specified amount. The idea behind this measurement of spring tension is that the wattage increases as the spring tension increases because the motor has to force harder to turn the parts which it is driving.

DRY BEARINGS

Another example was found during a service call at an industrial plant; one of their machines had developed a hot motor. The motor was smoking and the machine operator called for help. Without thinking, the most natural thing to assume would be that the motor itself had become defective and was the cause for trouble. An operating check with a Simpson Volt-Wattmeter showed that there was a continued high wattage and a low line

voltage.

This combination always indicates trouble. But this time, the trouble was not actually in the motor or in the electrical circuit at all. The machine which the motor was driving was in need of lubrication, and that was all that was wrong. The machine worked fine again after it was lubricated; another check with the Volt-Wattmeter confirmed the fact and showed that there was no permanent damage in the motor.

The same results would have been true for any other mechanical loading, too tight a drive belt, gears not properly meshed, or a foreign object caught in the moving parts. The presence of trouble will be reflected in the wattmeter and voltmeter readings which you can get with your Simpson Volt-Wattmeter. The same meters will indicate normal conditions after the trouble has been eliminated.

REFRIGERATORS

A third example, in which a low wattage indicated the presence and type of trouble, was a case of testing an old refrigerator

which had been in storage for some time and had not been used. When this refrigerator was plugged into the outlet of a Volt-Wattmeter, the voltmeter indicated satisfactory line voltage was present, and the wattmeter indicated that the motor ran through a normal starting sequence, but then the wattage levelled off at too low a value for normal operation. This means that the motor is not working as hard as it should.

When the pressure of the refrigerant was checked, it was found that, during storage, part of the gas had leaked out so the pressure was low. That accounted for the decrease in wattage drawn by the motor, and was a trouble which could be identified easily and quickly with the information from the Simpson Volt-Wattmeter.

SUMMARY

Summarizing the effects shown with the Volt-Wattmeter for motor circuits, the indications and probable troubles which they show are as follows:

APPLICATIONS

WATTS	VOLTS	POSSIBLE TROUBLE MECHANICAL	OR ELECTRICAL
Low	Low	-	Power source
Low	Normal	Decreased load	Increased resistance
Low	High	Decreased load	Increased resistance
Normal	Low	Increased load	Short circuit
Normal	Normal	None	None
Normal	High	Decreased load	Increased resistance
High	Low	Increased load	Short circuit
High	Normal	Increased load	Short circuit
High	High	-	Power source

In the above table, the idea of low, normal and high wattage ratings are related to the rated wattage for the device. If the power source voltage is low, the wattage indicated can be expected to be lower than the rated amount. Similarly, if the voltage is high, the wattage will be high under ordinary conditions.

CHECK TRANSFORMER-OPERATED CIRCUITS

If the voltage which furnishes operating power for a circuit comes from a secondary winding of a transformer, the loading of this secondary circuit will be reflected in the amount of current which passes through the primary winding of the transformer. As the current is increased through the secondary circuit, primary current is also increased. The Volt-Wattmeter will indicate the cumulative effects of all the secondary circuits for any transformer when you use it to measure primary wattage.

HIGH WATTAGE

When the wattage indication increases, there is more current being drawn through one or more secondary circuits. If the line voltage is high, this could be normal. But if the line voltage is normal or low, a high wattage probably indicates a partial short circuit in one or more secondary circuits of the transformer. Check each secondary circuit visually, or with another instrument if necessary, to locate and eliminate the exact reason for

your trouble. Then check again for normal operation indications with your Volt-Wattmeter after the fault has been eliminated.

LOW WATTAGE

If the wattmeter indicates that there is less than normal wattage, the trouble is probably that one or more of the secondary circuits is open. This can be an indication of faulty equipment, or it may simply indicate that a switch or circuit breaker is open. Examine the circuits in the secondary of the transformer to determine where the fault is, and then you can eliminate it. Recheck circuit operation with your Simpson Volt-Wattmeter after you have done any servicing on the device. See that you have eliminated the original trouble and that you have restored normal operating characteristics to the circuit.

INCREASED APPLICATIONS

Many other applications will suggest themselves as you learn to use and interpret the information on your Simpson Volt-Wattmeter. These examples are included to give you a

brief set of suggestions on which you will build your own service procedures.

The important thing to remember is that there are excellent and simple indications of trouble which you will have when you use your Simpson Model 391 or 392 Volt-Wattmeter to evaluate circuit operation. There is also an assurance of proper operating characteristics. Learn to interpret the information which your instrument makes available to you.

MEASURING WATTAGE FOR DIRECTLY CONNECTED DEVICES

Many devices with wattage ratings within the ranges of your Volt-Wattmeter will be connected directly across the power line without a power plug in a convenience outlet. Each of these will have a separate fuse.

The fuse may be located in a box on the device or on the wall nearby, or it may be a special fuse in the main fuse box.

When you wish to measure characteristics of the device with your Volt-Wattmeter, connect

the instrument in place of the circuit fuse as indicated in figure 4 or figure 5.

WARNING

Be sure to use the white dots to identify lead polarity. The white dot leads must both be connected to the unfused side of the power line or you will place a direct short across the power source. This can damage the instrument before a main fuse blows.

The leads connected to the white dot contacts are common through the instrument (see figure 3). The unmarked contacts identify the lead through which the circuit current must pass to reach the current coils of the wattmeter.

STEP-BY-STEP PROCEDURE

1. Disconnect the main power fuse to remove voltage from the contacts while you make your Volt-Wattmeter connections.

2. Remove the fuse for the circuit to the device which you wish to measure.

3. Connect an adapter to the power plug at

the end of the longer lead in your instrument. Be sure you know which wire is connected to the white dot contact on the plug.

4. Connect the adapter wire which is the white dot lead to the common, or unfused, side of the line in the fuse box. Connect the other adapter lead to the "hot" side of the line on the power side of the fuse (as shown in figure 4).

5. Connect an adapter to the power receptacle at the end of the shorter lead in your instrument. Again, be sure you know which wire is connected to the white dot contact on the receptacle.

6. Connect the adapter wire which is the white dot lead to the common, or unfused, side of the line in the fuse box. Connect the other adapter lead to the "hot" side of the fuse (as shown in figure 4).

7. Connect the main power fuse to apply power through the line to operate the device which you are testing.

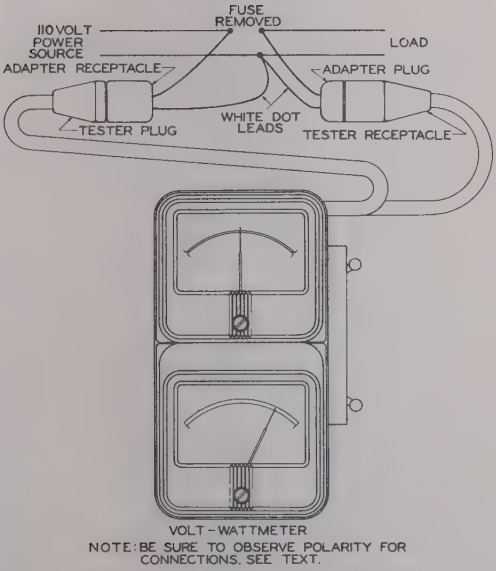


FIGURE 4. CONNECTING A VOLT-WATTMETER IN PLACE OF A FUSE IN A 110 VOLT CIRCUIT

WARNING

Do not touch the adapter connections while there is voltage applied to them.

8. Read the indications on your Volt-Wattmeter the same as for ordinary plug-in connections.

9. Disconnect the main fuse again before you take out the adapter connections and the Volt-Wattmeter.

Figure 5 shows the circuit connections which you can use to make similar connections for measurements in a 220 volt circuit. Use the same steps as for 110 volt circuits, described above, and use the side of the line from which you do not remove the fuse the same as the unfused line in 110 volt circuits. Be careful to observe lead polarity to prevent any damage to the instrument. Be sure to remove power from the circuit before you connect or disconnect any of the parts for these measurements.

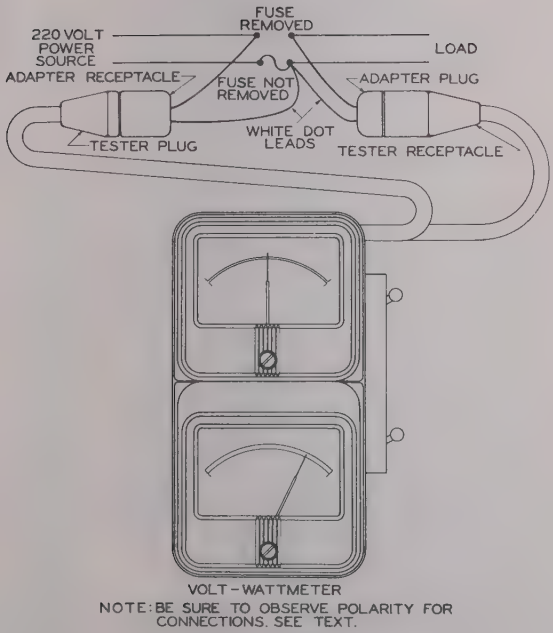


FIGURE 5. CONNECTING A VOLT-WATTMETER IN PLACE OF A FUSE IN A 220 VOLT CIRCUIT

SECTION V

REFERENCE INFORMATION

BASIC ELECTRICAL UNIT RELATIONS

WATTS

A watt is the practical unit of electrical power. It is equal to 10^7 ergs per second, 1 joule per second, or 1/746 horsepower. The number of watts of power in a circuit is equal to the number of volts multiplied by the number of amperes and, in the case of AC, by a power factor. This is also known by the term true watts, because it is a value which is directly related to the ability of a unit to perform its intended work. Your Simpson Volt-Wattmeter indicates true watts.

VOLT-AMPERES

A measurement which does not include a consideration of the power factor in AC circuits is called volt-amperes or apparent

power or apparent watts. It is simply the product of volts times amperes. This is the same value as true watts for DC circuits and for AC circuits which are pure resistance or resonant. If they are inductive or capacitive, the volt-ampere measurement is always more than the true wattage.

POWER FACTOR

The power factor is a fractional multiplier, as indicated above, which corrects apparent power to make the value of true power when dealing with inductive or capacitive AC circuits. It is equal to the cosine of the angle of lag or lead between voltage and current in the circuit. This value is maximum (1) when there is no lead or lag, or minimum (0) when there is a difference of 90° between voltage and current. When the phase angle is between 0° and 90°, the power factor will be between 1.0 and 0, and will be equal to the cosine of the phase angle.

ELECTRICAL AND MECHANICAL EQUIVALENTS

The standard measurement of power in electricity is in units of watts. In mechanical measurements, the units are horsepower (hp.). For convenience in relating electrical and mechanical measurements of power, use the following formulas:

1 horsepower = 746 watts = 0.746 kilowatt
1 kilowatt = 1000 watts = 1.34 horsepower

When you transfer energy from one form to another, there is always some loss. The above equivalents assume 100% efficiency in the power transfer, which is an ideal condition. Actually, the wattage rating for a 1/2 horsepower motor, for example, may be anything from 373 watts (746 divided by 2) on up, depending on how efficient the circuit is in accomplishing the power transfer.

RATINGS FOR AIR-CONDITIONERS

Air-conditioning equipment is coming into more popular use, increasing the possibility that you may have to service it in the near future. Since the nominal ratings for air-con-

ditioners are in units of tons, you will need to measure the normal wattage for each size and each brand to know what the expected indications will be. Some sample values are as follows:

1/3 ton, 110 volt 800 watts
1/2 ton, 110 volt 1050 watts
3/4 ton, 110 volt 1300 watts

Make your own table of wattages, using known good units, and use it to identify high and low wattage indications for each size.

SIMPSON WARRANTY REPAIR STATIONS AND PARTS DEPOTS

**ARIZONA, PHOENIX
Metercraft, Inc. 3304 N. 24th St.
States: Arizona
Phone: CRestwood 9-5287

CALIFORNIA, LOS ANGELES
Quality Electric Co., 3700 South Broadway
States: So. California below Fresno and Arizona
Phone: ADams 2-4201

CALIFORNIA, SAN FRANCISCO
Pacific Electrical Instrument Lab., 111 Main St.
States: No. California above Fresno and Nevada
Phone: GArfield 1-7185

**CANADA, LONDON, ONTARIO
Bach-Simpson Ltd., 1255 Brydges St., P.O. Box 484
Phone: GLadstone 1-9490

COLORADO, DENVER
Meter-Master Instrument Service, 2379 S. Downing St.
States: Wyoming, Utah, Colorado, and New Mexico
Phone: RAce 2-8670

CONNECTICUT, NEW HAVEN
Kaufman Instrument Labs., Inc., 810 Dixwell Ave.
States: Connecticut
Phone: SPruce 6-7201

*Parts Depots only; no repairs
**Repair Stations only; no resale of parts.
(All others repair instruments and sell repair parts)

FLORIDA, ORLANDO
Electro Tech Corp., 307-27th Street
States: Florida
Phone: GArden 3-5589

GEORGIA, ATLANTA
Electro-Tech Equipment, 690 Murphy Ave., S.W.
States: Alabama, Georgia, Carolina and Tennessee
Phone: PLaza 3-4128

**ILLINOIS, CHICAGO
Simpson Electric Company, 5200 W. Kinzie St.
Phone: EStebrook 9-1121

*ILLINOIS, CHICAGO
Pacific Indicator Company, 5217 W. Madison St.
States: Chicago, Wisconsin and Indiana
Phone: COlumbus 1-1330

**KANSAS, KANSAS CITY
Sturtz Instrument Co., 4705 Mission Road
States: Kansas
Phone: STarline 1-4711

LOUISIANA, NEW ORLEANS
Industrial Instrument Works, 3328 Magazine St.
States: Arkansas, Mississippi and Louisiana
Phone: TWinbrook 5-5621

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MASSACHUSETTS, CAMBRIDGE
Alvin C. Mancib Co., 363 Walden Street
States: Vermont, New Hampshire, Massachusetts, Rhode Island and Maine
Phone: UNiversity 4-2494

MICHIGAN, DETROIT
Ram Meter, Inc., 1100 Hilton Road, Ferndale
States: Michigan
Phone: LIncoln 7-1000

MINNESOTA, MINNEAPOLIS
Instrumentation Services, 917 Plymouth Ave.
States: Minnesota, North and South Dakota
Phone: KEllogg 7-5411

MISSOURI, ST. LOUIS
Scherrer Instruments, 5449 Delmar Blvd.
States: Illinois below Peoria, Iowa, Missouri
Phone: FOrest 7-9800

NEW YORK, BUFFALO
Electrical Instrument Labs, 932 Hertel Ave.
States: New York State except Met. New York
Phone: EXport 2-2726

NEW YORK, NEW YORK 7
Simpson Instrument Service Corp., 27 Park Place
States: Met. New York and New Jersey above Trenton
Phone: BArclay 7-4977

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(All others repair instruments and sell repair parts)

*NEW YORK, SYRACUSE
Syracuse Instrument Lab, 4895 South Ave.
Box 96
Phone: HYatt 2-1651

OHIO, CLEVELAND
Weschler Electric Co., 4250 W. 130th St.
States: Ohio and Kentucky
Phone: CLearwater 1-4609

**OKLAHOMA, TULSA
Tri-State Instrument Lab., 2216 N. Sheridan Road
States: Oklahoma
Phone: TEmple 5-1890

**OREGON, PORTLAND
Industrial Instrument Repair Lab.,
1910 N. Killingsworth St.
States: Oregon
Phone: BElmont 4-6683

PENNSYLVANIA, PHILADELPHIA
Sunshine Scientific Instrument, 1810 Grant Ave.
States: Pennsylvania, Maryland, New Jersey below
Trenton, Delaware
Phone: ORchard 3-5600

*Parts Depots only; no repair
**Repair Stations only; no resale of parts.
(All others repair instruments and sell repair parts)

TEXAS, DALLAS
Nelson Electronic Engineering Co., Inc.
6329 Gaston Avenue
States: Texas
Phone: TAylor 4-2626

**TEXAS, HOUSTON
Nelson Electronic Engineering Co., Inc.
3615 Gulf Freeway
Phone: CApitol 8-2835

VIRGINIA, FALLS CHURCH
United Instrument Lab., Inc.
1101 Jefferson St.
States: Washington, D.C., West Virginia, Virginia
Phone: JEfferson 2-1212

WASHINGTON, SEATTLE
The Instrument Lab, Inc.
934 Elliott Avenue West
States: Oregon, Washington, Idaho, and Montana
Phone: ATwater 3-5850

*Parts Depots only; no repairs.
**Repair Stations only; no resale of parts.
(All others repair instruments and sell repair parts)

WARRANTY

SIMPSON ELECTRIC COMPANY warrants each instrument and other articles of equipment manufactured by it to be free from defects in material and workmanship under normal use and service, its obligation under this warranty being limited to making good at its factory any instrument or other article of equipment which shall within 90 days after delivery of such instrument or other article of equipment to the original purchaser be returned intact to it, or to one of its authorized service stations, with transportation charges prepaid, and which its examination shall disclose to its satisfaction to have been thus defective; this warranty being expressly in lieu of all other warranties expressed or implied and of all other obligations or liabilities on its part, and SIMPSON ELECTRIC COMPANY neither assumes nor authorizes any other persons to assume for it any other liability in connection with the sale of its products.

This warranty shall not apply to any instrument or other article of equipment which shall have been repaired or altered outside the SIMPSON ELECTRIC COMPANY factory or authorized service stations, nor which has been subject to misuse, negligence or accident, incorrect wiring by others, or installation or use not in accord with instructions furnished by the manufacturer.

Simpson ELECTRIC COMPANY

5200 Kinzie St., Chicago 44, Illinois • Phone: ESTebrook 9-1121

In Canada: Bach-Simpson, Ltd., London, Ontario

LAC DU FLAMBEAU PLANT
WISCONSIN

LAKE STREET PLANT
CHICAGO

KINZIE STREET PLANT
CHICAGO

AURORA PLANT
AURORA, ILL.

Quality is the indispensable component
of every Simpson instrument . . . . . .